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⑤④ **Antenna for circularly polarised radiation.**

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GB-A-1 165 444
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US-A-2 800 657

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Description

The present invention relates to an antenna for circularly polarised radiation. Circular polarisation of RF radiation is known to be useful in various applications. For example, it is well known that circular polarisation can be helpful in radar systems in discriminating desired targets from clutter, especially rain clutter. Additionally, when a circularly polarised signal is reflected from a substantially smooth surface, such as the sea on a relatively calm day, the reflected signal becomes circularly polarised in the opposite hand. Thus, provision of an antenna system which discriminates in favour of circularly polarised signals in a particular hand can be useful in discriminating against such signals which have been reflected from the sea. This feature has particular applications in position fixing systems in which the distance of a station of which the position is to be found from transponders at known fixed positions is determined by interrogating the transponders and measuring the time delay of receipt at the interrogating station of response signals from the transponders. It can be appreciated that these time delay measurements can be substantially corrupted if the transponder, or the interrogating station responds to signals reflected from sea.

Antennas generally produce radiation which is linearly polarised on a particular axis. Circular polarisers are known for converting these linear polarised emissions to circularly polarised signals. In general, such circular polarisers are arranged as anisotropic regions, that is regions which have differing capacitive and inductive effects on the transmitted radiation in each of two orthogonal directions transverse to the direction of transmission. The orthogonal directions of the anisotropic region can be described as the orthogonal axes of the region. In one known example of circular polariser, parallel plates are used inclined at 45° to the linear polarisation axis of the radiation from the antenna which is to be circularly polarised. The components of the linearly polarised radiation having electric vectors parallel and orthogonal to the parallel plates of the polariser are changed in phase differentially as they pass through the polariser. Careful design of the spacing and depth (in the transmission direction) of the plates can arrange for this phase change to be 90°, thereby resulting in circular polarisation. It can be appreciated that the parallel plate polariser described above is essentially suitable only for signals transmitted with a substantially planar wave front in a predetermined direction. The system is not suitable for use in a compact arrangement on a wide beam antenna.

The prior art also includes a number of printed polarisers in which anisotropic arrangements of conductors are provided on insulating supporting sheets. However, with such arrangements it has hitherto been found necessary to use at least two such anisotropic sheets or layers to minimise reflections from these layers resulting in serious

mis-match at the antenna. However, anisotropic layer polarisers of this kind can be shaped to correspond to the wave front of signals from the antenna and therefore used in wide beam applications. Reference may be made to GB-A-1240529.

There is a clear need for a more compact circular polarising arrangement providing good polarisation discrimination in a compact antenna whilst affording reasonable or good matching at the antenna without excessive voltage standing wave ratio (VSWR).

According to the present invention, an antenna for circularly polarised radiation comprises a linear array of primary radiation elements having a common linear polarisation and a common axis, and means to supporting a single anisotropic sheet shaped to be substantially parallel to the wave fronts of radiation emitted by the array, the orthogonal axes of the anisotropic layer being at acute angles to the linear polarisation of the primary radiating elements, the geometry and structure of the anisotropic sheet and the radial spacing of the sheet from the array is selected such that repeated reflections between the sheet and the primary radiating elements produce a radiated wave from the antenna which is circularly polarised.

The above invention is based primarily on the somewhat surprising discovery that a satisfactory antenna with circular polarisation can be produced using a single anisotropic layer. By carefully designing the anisotropic layer itself and careful spacing of the anisotropic layer from the primary radiating elements, mis-matching of the antenna can be minimised and good circular polarisation achieved.

It will be appreciated that, as normal in antenna systems, the present antenna can be equally suitable for receiving radio frequency radiation as for transmitting and references throughout this specification to radiations and emissions from the antenna are included solely for convenience in describing the antenna and should not be construed as limiting the antenna to transmission applications.

Conveniently said supporting means of the antenna comprises a radome of dielectric material carrying the anisotropic layer. The anisotropic layer may comprise parallel spaced conductors extending in one of the orthogonal axes of the layer. The spaced conductors may be at 45° to the common linear polarisation of the radiating elements.

In one arrangement the linear array provides omnidirectional radiation in planes perpendicular to the array and said anisotropic layer forms a complete cylinder surrounding the array.

Examples of the present invention will now be described in greater detail with reference to the accompanying drawings in which:

Figure 1 is a partial view of an antenna for circularly polarised radiation with a portion of the radome and anisotropic layer broken away for clarity and

Figure 2 is an alternative embodiment of

antenna employing a different form of primary radiating element.

Referring to Figure 1, the antenna comprises an array of three dipole radiators 10 stacked end to end along a common axis 11. The detailed construction of the dipole radiators 10 of the array is not essential to the understanding of the present invention and nothing more will be included herein. It can be seen that the dipoles 10 of the array have a common linear polarisation producing, in the absence of any circular polariser, radiation with an electric vector parallel to axis 11. Furthermore, it can be seen that the array of dipoles 10 can produce radiation in all directions in a plane parallel to the axis 11. Thus, with the axis 11 vertical, the antenna is omnidirectional in azimuth.

The array of dipoles 10 is enclosed in a cylindrical radome of which a lower part only is shown at 12. The upper part of the radome is broken away for clarity so as to reveal the dipole array. The cylindrical radome 12 is arranged to surround the dipole array so that the axis 11 of the array is on the axis of the cylinder of the radome. The radome is made of a dielectric material and is arranged to provide substantial weather protection for the antenna. For example the antenna may form the antenna of a transponder unit in a navigation or position fixing system and may therefore be located in an unattended and exposed position for example on the coastline.

In this example of the present invention, the radome 12 also supports an anisotropic layer formed of parallel helical wires or conducting paths 13. The wires 13 are either embedded in the thickness of the dielectric material of the radome 12 or supported on the inside wall of the radome. In an alternative arrangement the wires or paths 13 may be contained between an inner and an outer layer of the radome. For example the paths may be supported on the outer cylindrical surface of a rigid plastics cylinder forming an inner layer of the radome and providing the mechanical strength of the radome. The conducting paths 13 of the anisotropic layer are then encapsulated by an outer layer of the radome which may for example be formed of a heat shrinkable plastics shrunk onto the inner layer of the radome to cover the conducting paths.

The helical wires or conducting paths 13 are arranged with a helical pitch of 45° so that they are always at 45° to the axis 11 of the dipole array.

It will be appreciated by those experienced in this field that the components of the radiation emitted by the dipole array which are perpendicular and parallel respectively to the paths or wires 13 will be affected differently by the anisotropic layer. The component which is perpendicular to the wires or paths 13 will see the anisotropic layer as more capacitive than the component parallel to the wires, which latter will in turn see the layer as more inductive. It will be appreciated also that there will be reflections from the anisotropic layer back towards the array of dipoles and return reflections from the dipoles.

It has been discovered that careful selection of the design of the anisotropic layer and the material and thickness of the radome, together with careful spacing of the radome and anisotropic layer from the dipole array can result in producing effective circular polarisation of radiation emitted by the array with reasonable or good matching of the antenna.

The selection of the various parameters of the antenna is largely, though not entirely, an empirical process and of course these parameters will be different for different applications and, in particular, different frequencies.

In one example, an antenna as shown in Figure 1 was made to operate at a wave length of about 7 cm with a spacing between the helical wires 13 of about 1.5 cm and a radius from the anisotropic layer to the axis of the dipole array of about 4.5 cm.

Referring now to Figure 2, an alternative arrangement is shown which is essentially similar to that of Figure 1 except that the primary radiating elements are slots 14 in a wave guide 15. Again the slotted wave guide is enclosed in a substantially cylindrical radome carrying helical wires or conducting paths to form a single anisotropic layer. In other respects, the arrangement of Figure 2 may be substantially similar to that of Figure 1.

Claims

1. An antenna for circularly polarised radiation comprising a linear array of primary radiating elements (10) having a common linear polarisation and a common axis, and means (12) supporting a single anisotropic sheet (13) shaped to be substantially parallel to the wave fronts of radiation emitted by the array, the orthogonal axes of the anisotropic layer being at acute angles to the linear polarisation of the primary radiating elements, characterised in that the geometry and structure of the anisotropic sheet and the radial spacing of the sheet from the array is selected such that repeated reflections between the sheet and the primary radiating elements produce a radiated wave from the antenna, which is circularly polarised.

2. An antenna as claimed in Claim 1 wherein said supporting means comprises a radome of dielectric material carrying the anisotropic sheet.

3. An antenna as claimed in either of Claims 1 or 2, wherein the anisotropic sheet comprises parallel spaced conductors extending in one of the orthogonal axes of the sheet.

4. An antenna as claimed in Claim 3, wherein said spaced conductors are at 45° to the common linear polarisation of the radiating elements.

5. An antenna as claimed in any preceding claim wherein said linear array provides omnidirectional radiation in planes perpendicular to the array and said anisotropic sheet forms a complete cylinder surrounding the array.

Patentansprüche

1. Antenne für kreispolarisierte Strahlung mit einer gemeinsamen linearen Polarisierung und einer gemeinsamen Achse besitzenden linearen Anordnung von Primärstrahlungselementen (10), und mit Halterungsmitteln (12) für eine einzige anisotrope Schicht (13), die so geformt ist, daß sie im wesentlichen parallel zu den Wellenfronten der durch die Anordnung emittierten Strahlung verläuft, wobei die orthogonalen Achsen der anisotropen Schicht unter spitzen Winkeln zur linearen Polarisierung der Primärstrahlungselemente verlaufen, dadurch gekennzeichnet, daß die Geometrie und der Aufbau der anisotropen Schicht und der radiale Abstand der Schicht von der Anordnung so gewählt sind, daß wiederholte Reflexionen zwischen der Schicht und den primärstrahlungselementen eine abgestrahlte Welle von der Antenne erzeugen, welche kreispolarisiert ist.

2. Antenne nach Anspruch 1, bei der die Halterungsmittel durch eine Antennenverkleidung aus dielektrischem Material gebildet sind, welche die anisotrope Schicht trägt.

3. Antenne nach Anspruch 1 oder 2, bei der die anisotrope Schicht parallele beabstandete Leiter umfaßt, die in einer der orthogonalen Achsen der Schicht verlaufen.

4. Antenne nach Anspruch 3, bei der die beabstandeten Leiter unter 45° zur gemeinsamen linearen Polarisierung der Strahlungselemente verlaufen.

5. Antenne nach den vorhergehenden Ansprüchen, bei der die lineare Anordnung eine Rundstrahlung in Ebenen senkrecht zu ihr erzeugt und bei der die anisotrope Schicht einen die Anordnung umgebenden vollständigen Zylinder bildet.

Revendications

1. Une antenne pour rayonnement à polarisation circulaire comprenant un réseau linéaire d'éléments rayonnants primaires (10) ayant une polarisation linéaire commune et un axe commun, et un moyen (12) de support d'un feuillet anisotrope unique (13) conformé pour être sensiblement parallèle aux fronts d'ondes de rayonnement émis par le réseau, les axes orthogonaux de la couche anisotrope étant à des angles aigus par rapport à la polarisation linéaire des éléments rayonnants primaires, caractérisée en ce que la géométrie et la structure du feuillet anisotrope et l'espacement radial du feuillet par rapport au réseau est choisi de telle sorte que des réflexions répétées entre le feuillet et les éléments rayonnants primaires produisent une onde rayonnée à partir de l'antenne qui est polarisée circulairement.

2. Une antenne selon la revendication 1 où ledit moyen de support comprend un radome en matériau diélectrique portant le feuillet anisotrope.

3. Une antenne selon l'une quelconque des revendications 1 ou 2, où le feuillet anisotrope comprend des conducteurs parallèles espacés s'étendant selon l'un des axes orthogonaux du feuillet.

4. Une antenne selon la revendication 3 où lesdits conducteurs espacés sont à 45° par rapport à la polarisation linéaire commune des éléments rayonnants.

5. Une antenne selon l'une quelconque des revendications précédentes, où ledit réseau linéaire produit une radiation omnidirectionnelle dans des plans perpendiculaires au réseau et ledit feuillet anisotrope forme un cylindre complet entourant le réseau.

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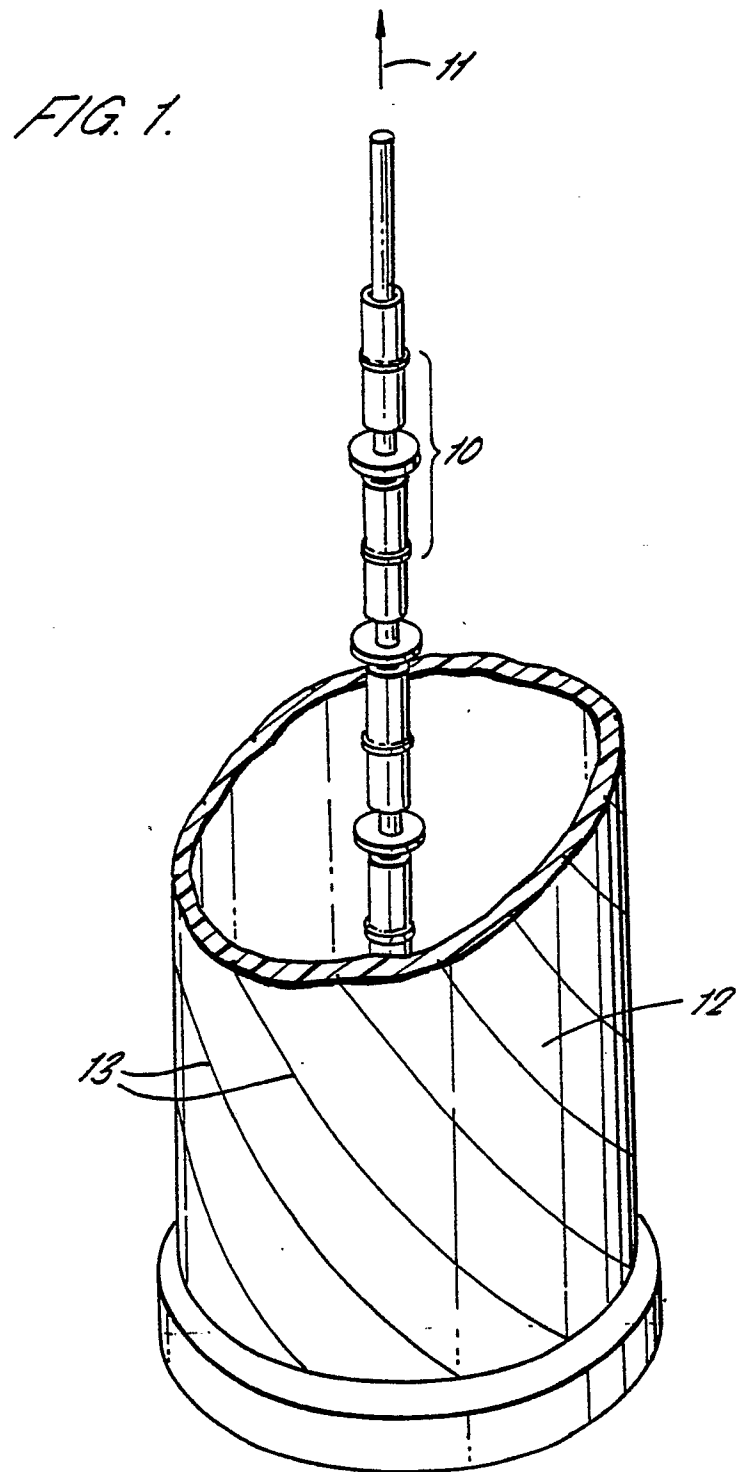


FIG. 2.

